Space Weather Technical Forecast

Issued on Monday, 08 January 2024 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low activity with peak flare of C8.7 at 07/2225 UTC from AR3534 as it rotated over the southwest limb. There are nine sunspot regions on the disc, with six of these in the northwest, including previously active AR3536, although this continues to gradually weaken. The most notable growth was observed by AR3543, closer to the solar equator, however this maintained a simple magnetic configuration. Two further regions AR3540 and AR3541 are in the southeast, and continue to show some development. AR3540 is the northernmost and more mature spot, with only slow evolution occurring, while AR3541 showed some growth in both umbra and penumbra extent, but remains the smaller of the two. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted, with observed winds by ACE at L1 persisting at background 300-320km/s. Density remained below average. Interplanetary magnetic field (IMF), Bt was weak (0-6nT) with a variable north-south component, Bz, ranging +2 to -3 nT. Phi angle was negative (towards the Sun) until 07/1720 UTC, then positive (away from the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux continued to gradually decline towards background, with peak 1.58 pfu at 07/1445. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was below Active throughout. The 08/0000 UTC observation was 3.44e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is an ongoing chance of isolated M-flares due to the nine sunspot groups on the disc and a further region or regions soon expected to rotate on. There is a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are two potential glancing CME impacts, one from 05 Jan, arriving day 1-2 (08-09 Jan) and another from 06 Jan, arriving day 2-3 (09-10 Jan), however these are both low confidence. Otherwise some interaction with the fast wind of CH89/+ remains possible day 1-2 (08-09 Jan), but this is likely to have only a very limited impact on observed solar winds. Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled days 1-3 (08-10 Jan), with a chance of Active, along with any CME arrival.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to continue declining towards background through the period, but with a slight chance of seeing further increases towards the S1 minor radiation storm threshold given any notable flaring. The high energy electron flux is forecast to remain at mainly background with no notable enhancements expected, and the associated 24 hour electron fluence persisting below the Active (1e8) threshold.

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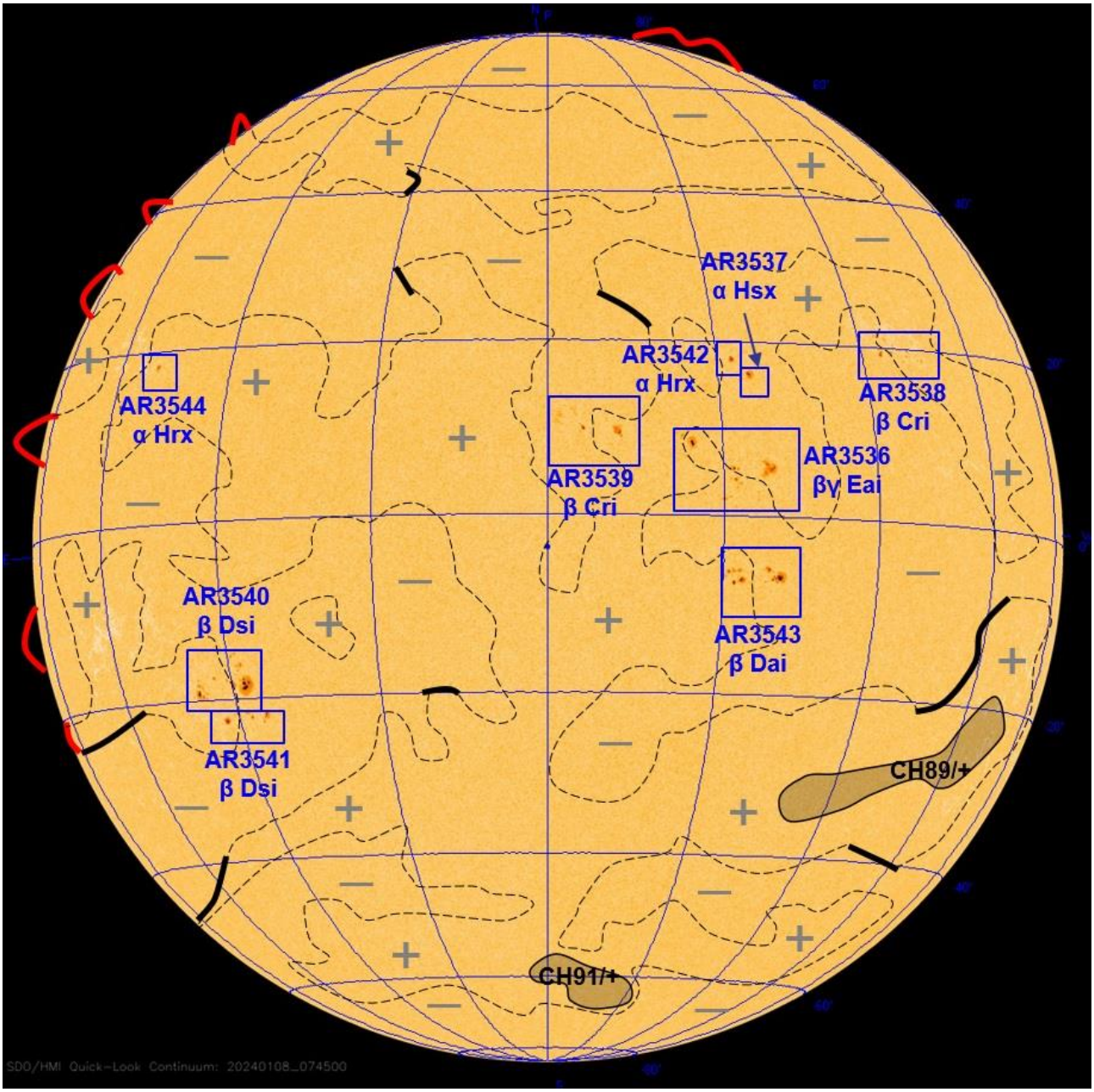
Figure 1. Solar Analysis Valid 08/0800.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs with potential for Earth-directed components. The first from the northeastern quadrant on 05 January (but directed southeastward) is forecast to perhaps glance the Earth either late day 1 or early day 2 (08-09 Jan). Secondly, a filament eruption CME on 06 Jan been passes close to Earth late day 2 or early day 3 (09-10 January) with the potential for a very slight glancing blow, albeit with very low confidence.

Slow winds have persisted at Earth, contrary to current MOSWOC enlil expectations which would have Earth within a moderate fast wind from CH89/+, of around 550km/s. While some connection to this feature remains possible while it is featured on the southwest limb, it is also possible that Earth remains north of any fast wind that emanates from this coronal hole. Overall, peak winds of around 400-450km/s are possible day 1 into day 2 (08-09 Jan) before easing back to background.

Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled with a chance of Active, with any CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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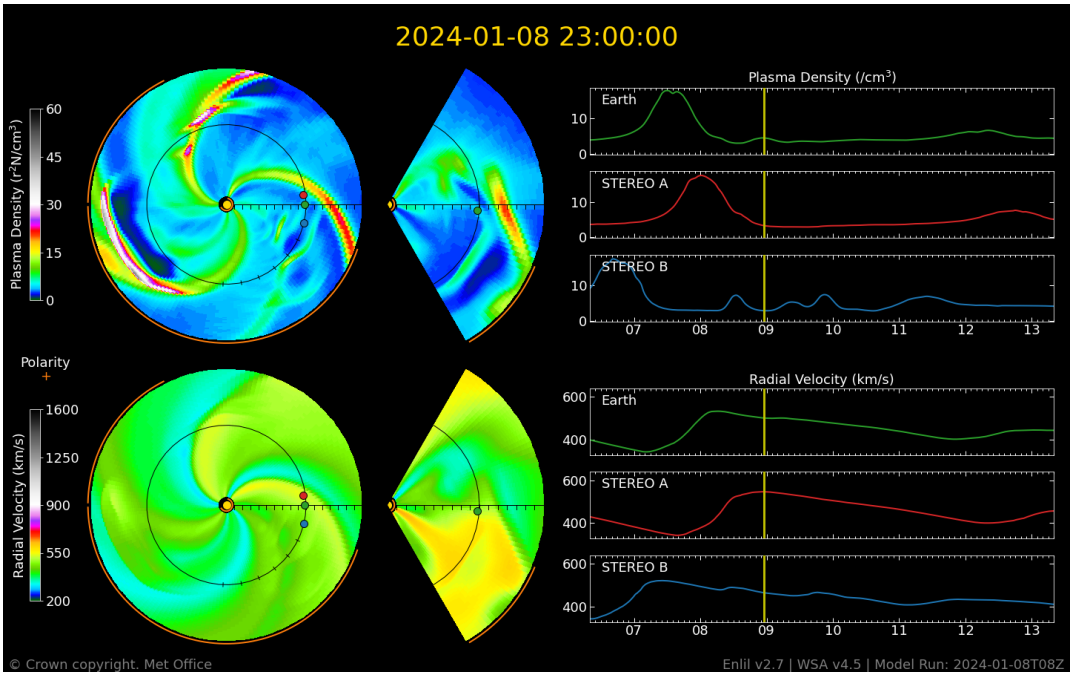
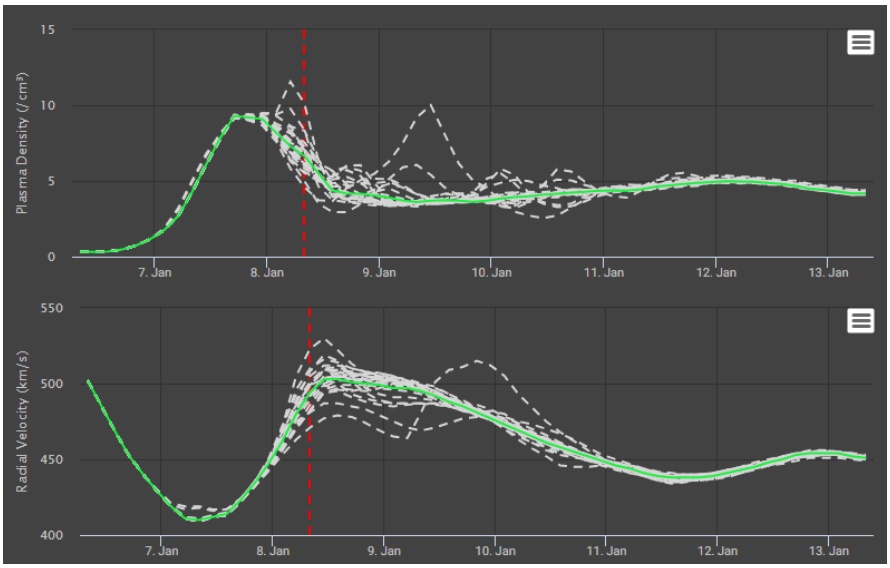
Figure 2: MOSWOC Enlil and Ensemble showing glancing CME arrivals





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Radio Blackouts - X-Ray Flares:

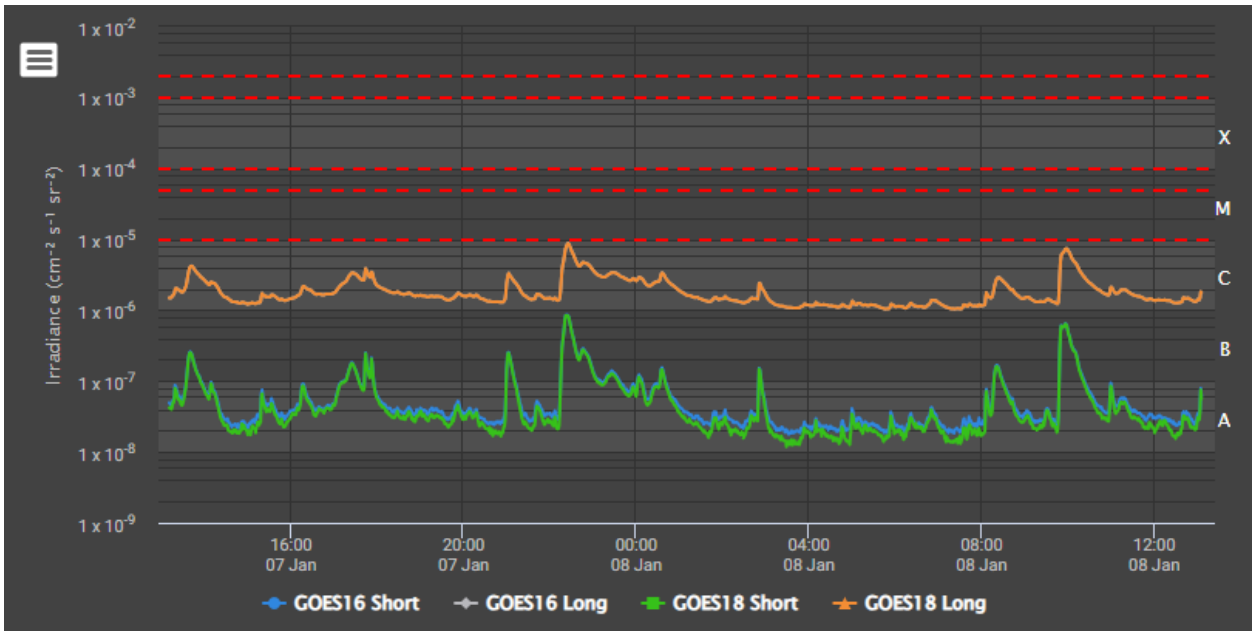
Low to Moderate activity is expected, with an ongoing chance of isolated M-flares with nine sunspot groups on the disc. There is a slight chance of X-class flares.

These regions are dominated by two clusters. On the northwest disc, previously active AR3536 has continued to show some slow simplification and decay, with nearby AR3537, AR3542 and AR3538 all smaller and either on either a stable or gradually weakening trend. AR3539, closer to the centre disc, has exhibited a little more dynamical evolution, with the emergence of small dark umbrae cores, but remains magnetically simple. Finally, more equatorial AR3543 has shown some development, but is maturing into a simple and open bipolar group. The other cluster in the southeast is formed of two spots. The larger, northernmost region remains modestly sized, but has seen its magnetic structure simplify to a standard bipolar group, with some small growth in the region to the south.

There are also further regions expected to rotate on, with notable magnetic looping evident on the SE limb on SDO aia-171, and any such regions will also increase the chance of notable flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	55	55	55	55
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES-16/18 X-ray Flux



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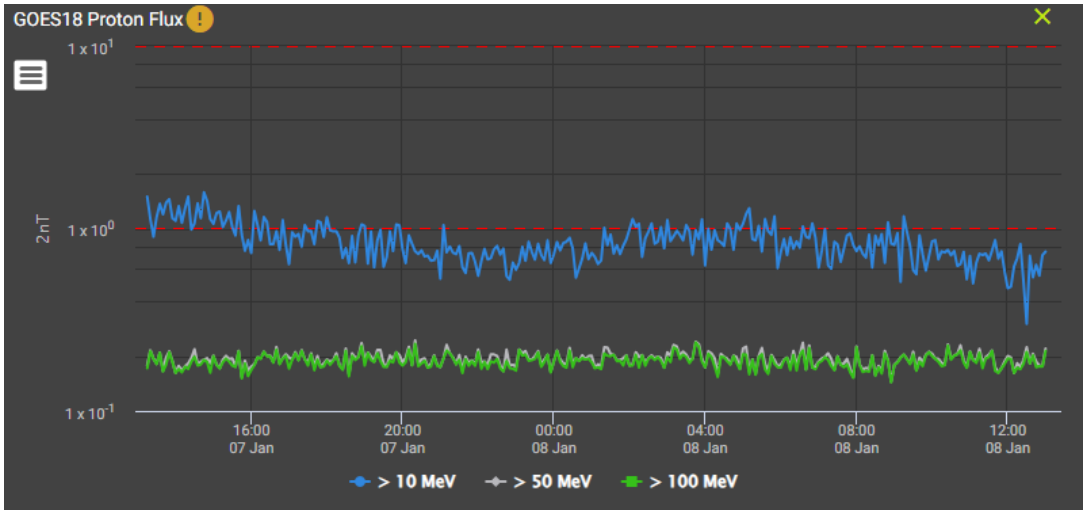
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently slightly above background, due to the ongoing effects of the Dec 31 X5.0 flare, and expected to continue to gradually ease. With a number of sunspots on the visible disc, and a large number in the western hemisphere, any further notable flares will also bring a risk of proton flux rising. This will bring a slight chance of reaching the S1 Minor Radiation Storm threshold.

Please note: GOES-18 is currently being used as the primary proton instrument, with GOES-16 data currently unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 >10 MeV, >50 MeV, >100 MeV Proton flux



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is currently at background, and in the absence of any significant enhancement is expected to persist at this level. Although brief periods of Moderate flux are possible day 3-4 (10-11 Jan) with in response to any fast wind or CME enhancements that occur.

The associated 24 hour fluence is expected to remain below the Active threshold, with REFM providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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